SEWERAGE SYSTEM IN URBANIZED AREA TO IMPROVE WASTE WATER MANAGEMENT

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ABSTRACT

The objectives of writing this dissertation are to study and list the problems due to existing sewerage system in Ranchi and how combined/Separated sewerage system could be a better replacement of existing sewerage system. Ranchi is the capital of the Indian state of Jharkhand. As Ranchi became capital in 2000, it emerges as a hub for new opportunities and employments. It entice people to migrate there for the betterment of their lifestyles. And Ranchi started accumulating a huge numbers of population every year and now a days this overcrowding became an issue. Which gives birth to many problems, which infects today's lifestyle. And one of the major problems is absence of a well-managed sewerage system in Ranchi. This sewerage system/network is operated and maintained by Ranchi Municipal Corporation. This city has a traditional type of sewerage system which is not enough for today's sewage load. As the result it overflows most of the time mainly in rainy season. It not only disturb the road movement but also creates an unhealthy environment. This system could be replaced by combined sewerage system. Because this system is better for cities like Ranchi and it can be installed in the pits of existing sewerage system and do not require on-site pre-treatment or storage of the wastewater. It contains long cylindrical pipes with pumping stations, accessible manhole which carry sewage as well as storm water. As it is underground it prevents from overflow and provide a high level of hygiene and comfort for the user at the point of use. This research would provide a frame of solution to the government body (municipal corporation), who can initiate a programme for the development and upgradation of the city. And it would help to find the scope for improvement of sewerage system in Ranchi for the welfare of society to make city clean and healthy for present as well as future.

KEYWORDS: Combined Sewerage System, On-Site Pre-Treatment, Pumping Stations

Now a days as the urbanization is taking a rapid speed, waste water management system is deprived in many areas/localities in India. Which give birth too many problems like dirty and unhealthy environment. It is happening because we are dependent upon old-style drainage system which is being failed due to overload of sewages. It is not capable for carrying total waste produced as the amount and types of waste increased. So there is too much need of a good sewerage system of those areas/locality for the betterment of waste water drainage system. So that we can improve waste water management of that area/locality and provide a healthy living and environment.

Sewerage system is the infrastructure that conveys sewage or surface runoff, using sewers. It encompasses components such as receiving drains, manholes, pumping stations and screening chambers of combined sewer or sanitary sewer. The main part of such system is made up of large pipes (sewers) that convey the sewage from point of production to the point of treatment or discharge.

COMBINED SEWERAGE SYSTEM

Combined sewerage system is type of sewerage system in which there is a large networks of underground pipes that convey domestic sewage, industrial wastewater and storm water runoff in the same pipe to a centralized treatment facility. Recent archaeological discoveries have shown that some of the earliest sewer systems were developed 2500 BC in the ancient city of Harappa.

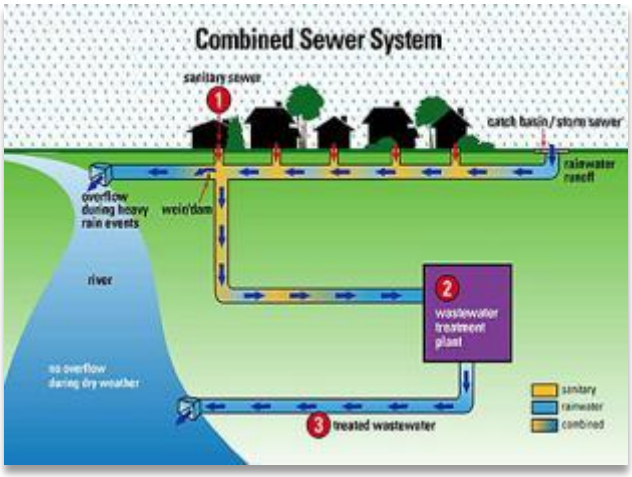

Figure 1: Combined Sewerage System

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Mostly it is found in urban areas and do not require on-site pre-treatment or storage of the wastewater. All their wastewater is transported to a Waste Water Treatment Plant where it is treated and discharged to a water body. (Combined sewer, n.d.)

Because the wastewater is not treated before it is transported, the sewer must be designed to maintain self-cleansing velocity (i.e. a flow that will not allow particles to accumulate), generally obtained with a minimal flow of 0.6 to 0.75m/s. A constant downhill gradient must be guaranteed along the length of the sewer to maintain self-cleansing velocity. When the required slope cannot be maintained, a pumping station must be installed. Primary sewers are laid beneath roads, at minimal depths of 1.5 to 3 m to avoid damages caused by traffic loads. Access manholes are set at regular intervals along the sewer, at pipe intersections, at changes in pipeline direction and at drops.

Another solution is to build a Combined Sewer Overflow storage facility, such as a tunnel that can store flow from many sewer connections.

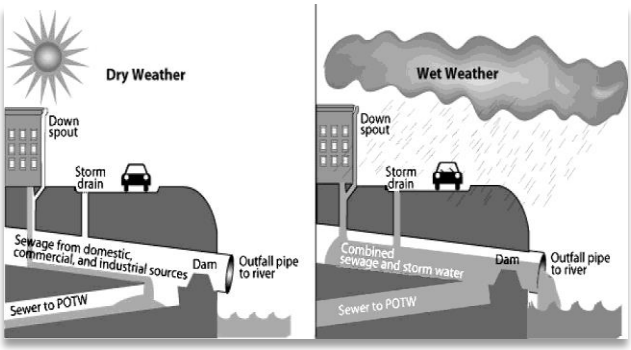

Figure 1: Combined Sewer Overflow in monsoon weather

During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called combined sewer overflows (CSOs), contain not only storm water but also untreated human and industrial waste, toxic materials, and debris.

Combined Sewer Over Flow discharges during heavy storms can cause serious water pollution problems. The discharges contain human and industrial waste, and can cause beach closings, restrictions on shellfish consumption and contamination of drinking water sources.

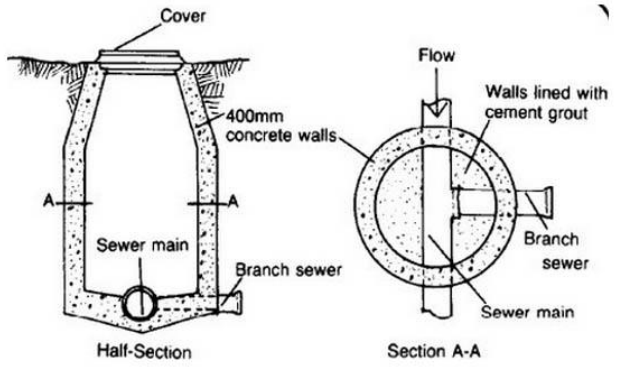

Figure 2: Section of manhole, Combined sewers

ON-SITE PRE-TREATMENT

Advanced wastewater treatment increases the percentage of contaminants, particularly nitrogen and fecal coliform, removed in wastewater. Advanced pretreatment components typically follow primary treatment from septic tanks and decrease the constituents of concern before they reach the final treatment and dispersal component. Advanced pretreatment components are used when a site has a high risk to public or environmental health and primary treatment is not protective enough.

Onsite (or decentralized) wastewater treatment systems are used to treat wastewater from a home or business and return treated wastewater back into the receiving environment. They are typically referred to as septic systems, because most involve a septic tank for partial treatment.

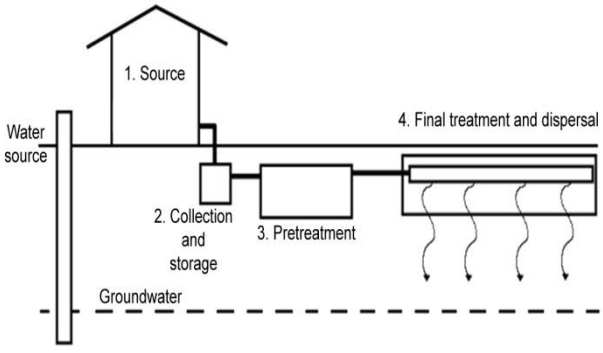

Figure 3: Component of an onsite pre-treatment system

EXIXTING SEWRAGE SYSTEM OF RANCHI

Sewerage system**,** network of pipes, pumps, and force mains for the collection of wastewater, or sewage, from a community. Modern sewerage systems fall under two categories: domestic and industrial sewers and storm sewers. Sometimes a combined system provides only one network of pipes, mains, and outfall sewers for all types of sewage and runoff. The preferred system, however, provides one network of sewers for domestic and industrial waste, which is generally treated before discharge, and a separate network for storm runoff, which may be diverted to temporary detention basins or piped directly to a point of disposal in a stream or river.

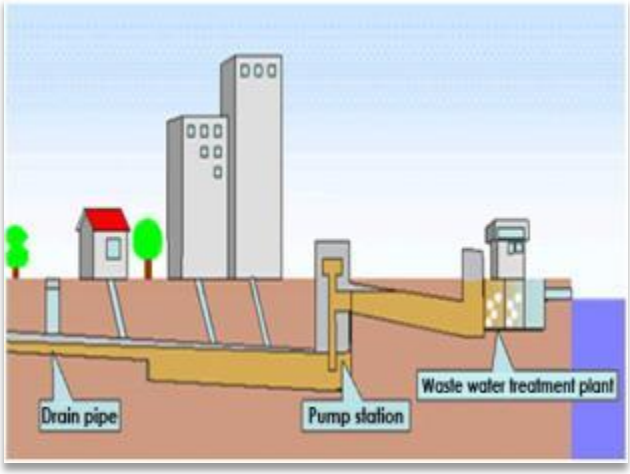

Figure 4: Sewerage System Network

ZONAL DIVISION OF SEWERAG SYSTEM NETWORK IN RANCHI

In Ranchi master plan-2037, sewerage system of Ranchi divided into 6 sewerage zones, according to the topography, terrain and nearest water body which can give most efficient results. Which covers the CBD and the suburbs of Ranchi. Zone-I is the largest sewerage zone among all VI zones, and Zone-III is the smallest sewerage zone. (Feedback Infra)

Figure 5: Map of zonal division of sewerage system, Ranchi

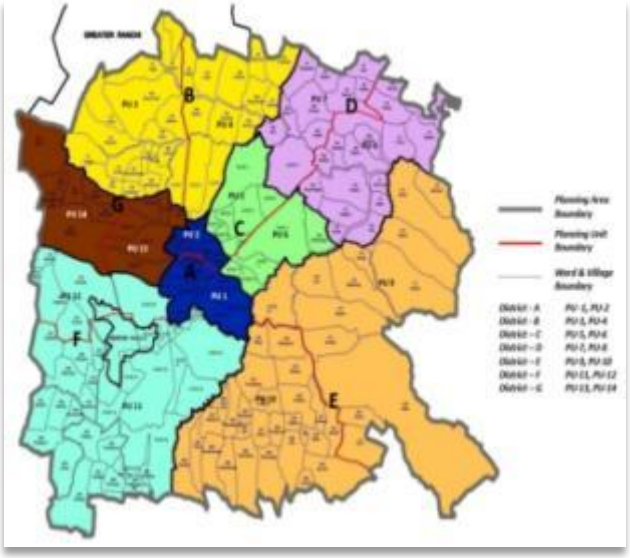

Figure 6: Division of area of Planning Units, Ranchi

These sewerage zones covers all the Planning Units of Ranchi. Below there is Planning Unit distribution map (Fig- 16). In Ranchi Planning Area there is 55 wards of Ranchi Municipal Corporation and it also includes 118 revenue villages along Ranchi city. (Ref.- Ranchi master plan-2037). Ranchi Planning Area have been divided into these Planning Units to make Higher Systematic Planning easy. Whose average population is between 5-6 lakhs.

Planning Units	Covered Area
PU-1	वार्ड 14, 15, 25, 26, 27, 28, 29, 47, 48 and 50
PU-2	वार्ड 16, 17, 18, 19, 22, 23, 24, 30 and 31
PU-3	वार्ड 1, Jaipur (189), Garu (153), Kadma (155), Ratu (79), Tendar (77), Kamre (144), Jhiri (145), Sundil (146), Dhamaisoso (147), Chatakpur (148), Naudsoso (150), Kamta (152) and Konje (151)
PU-4	वार्ड 2 and 3, Kanke (156), Arsande (159), Boreya (185), Sangrampur (160), Patratu (161), Hochar (158), Banhura (49) and Dubhiya (48)
PU-5	वार्ड 4, 6, 8, 9, 10, 20 and 21
PU-6	वार्ड 7, 11, 12, 13 and village Khatanga (179)
PU-7	वार्ड 5, village Lem (162), Partial village Getlatu (166), Renro (163), Kadal (165), Chuttu (164), Partial village Neyuri (45), Oyna (46), Chandwe (47), Partial village Kollari (28), Irba (27), Partial village Mesra (169)
PU-8	Lalganj (171), Dumardaga (181), Sugnu (170), Jamunari (17), Partial Village Getlatu (166), Hambai (167), Partial village Mesra (169), Rudiya (168), Partial village Rukka (31), Hutup (29), Karma (30), Turup (16), Hesal (19), Tati (173), Partial village Silwai (174), Partial village Berwari (20) and Salhan (15)
PU-9	वार्ड 49, Village Ara (178), Bargawon (216), Baram (177), Pertol (172), Partial village Sidraul (218), Kewali (217), Haratu (175), Partial village Silwai (174), Partial village Berwari (20), Partial village Hesal (19), Chatra (31), Mahilong (176), Ulatu (339), Chene (337), Partial village

Figure 7: Areas under Ranchi Planning Area-1

Planning Units	Covered Area
	Ganrke (335), Partial village Rampur (336) and Partial village Palandu (331)
PU-10	Partial village Bargawon (216), Khijiri (219), Partial village Sidraul (218), Partial village Palandu (331), Partial village Ganrke (335), Tumbagotu (301), Kutiatu (330), Kutetoli (299), Chandaghasi (300), Mariyatu (303), Oberiya (297), Ithe (304), Churu (327), Pindarkom (328), Sahera (329), Dungri (294), Tanko (295), Garhkhatanga (296), Lolkhatanga (305), Kochbang (306), Kharsidag (326), Tetri (325), Amna (333), Malti (332), Jordag (324), Sarwal (334), Lodhma (302) and Partial village Rampur (336)
PU-11	वार्ड 39, 40, 41, 42, 43, 44, 45, 46, 51, 52, 53, 54, 55, village Laved (233), Harser (235), Nachiatu (241), Hotwasi (232), Partial village Tundul (231), Partial village Kudlum (124), Balalong (236), Baridih (237), Semba (239), Bhandratoli (240), Singhpur (238), Chete (256), Sithiyo (255), Pindarkom (254), Balsiring (253), Jojosiring (252), Hulhundu (266), Sukurhuttu (269), Ghuthiya (265), Jamgain (264), Sohdag (257)
PU-12	वार्ड 38, Village Gutuwa (138), Partial village Tundul (231), Saparom (137), Meral (134), Daladili (133)
PU-13	वार्ड 32, 33, 34, 35, 36 and 37
PU-14	Pirra (93), Dandaiphuthatoli (95), Tilta (94), Partial village Pandra (149), Dahisot (143), Simliya (139)

Figure 8: Areas under Ranchi Planning Area-2

CURRENT SCENARIO OF OF SEWERAGE SYSTEM

Figure 9: Existing sewer (Open Nallah)

Areas under the Ranchi Planning Units have their own sewerage system that is mostly open sewer line and in some areas it is covered with precast concrete slab. Waste water management is operated and maintained by Ranchi Municipal Corporation. There is four major dams namely Rukka dam, Harmu dam, Getalsut dam, Kanke dam, into which all the waste water of whole city is drained directly without any treatment except Rukka dam. There is many industries like Heavy Engineering Corporation Limited, Tatisilwai, Suvarnarekha Watch Factory etc. in Ranchi Planning Area. These industries drain their waste water into sewers which reaches to Suvarnarekha river. Mainly there is five types of buildings in Ranchi city like commercial, residential, industrial institutional and hospitals. They all produce waste water of different types. Mainly the hospitals and industries produce toxic waste, if it would be drained without any treatment to the water sources it would make it polluted.

Ranchi city has mainly six industrial areas like Tupudana, Kokar, Getalsut, Namkum, Tatisilwai Phase-I and Tatisilwai Phase-II. All these industrial areas acquire approx. 204.74 hectares of land. These industries include Agro based, Cotton textile, Woolen, silk & artificial Thread based clothes, Paper & Paper product, Rubber, Plastic & petro based Mineral based etc. Which produce a huge amount of toxic solid and water waste.

Figure 10: Industrial waste water is directly drained into open sewers

Maintenance and cleaning of sewers are done by Ranchi Municipal Corporation. Solid waste is separated manually once or twice in a week. And that solid waste is carried out by tractors or small carts. Some sewers are covered with concrete slab and some are open.

Figure 11: Open sewer line, Hindpiri, Ranchi

The main residential area of Ranchi are Hindpiri, Kanke, Bariatu, Doranda, Kantatoli, Refugee colony, Sai colony, Vidya nagar colony, Harmoo colony, Ashok Nagar, Shamlong, Shyamali, Hinoo, Birsa Nagar, Hatia, Patel Nagar etc. These area generate huge amount of sewages. In these area there is open waste water drainage system which is not capable for the sewage produced today. Ranchi city also having large numbers of institutional building which produce huge amount of swages every day, which is directly drained into open sewers, which further drained into water bodies without untreated. And the sewers were of old time, which is not capable for sewages generated today. Which results overflow time to time and mainly in rainy season.

Figure 12: Open sewer, Main road, Ranchi

In Ranchi different area having different sizes of sewer lines, which included small sewer line, sub-main sewer line and main sewer line which carry sewages to the water body or STP.

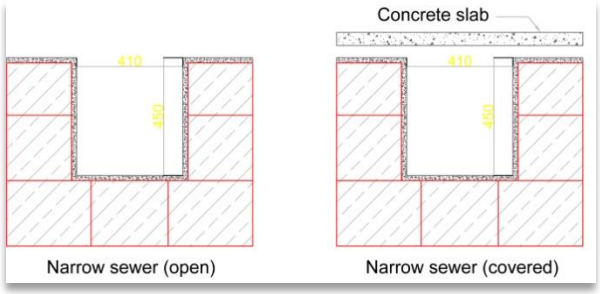

Figure 13: Section of narrow sewer lines in small streets

Narrow sewer line is made in small streets, which receive waste water from household, which again drained to sub-main sewer line and further drained to main sewer line, which carry sewages to the STP or water bodies.

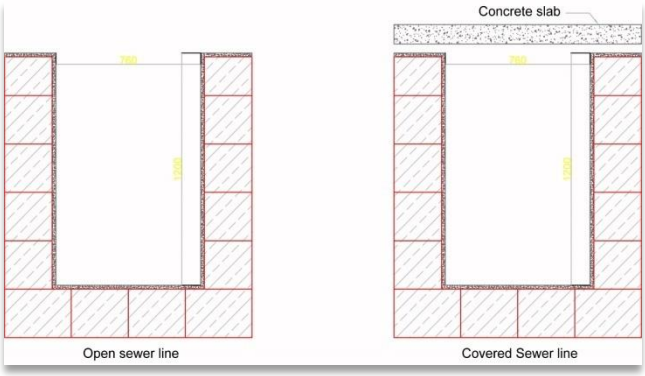

Figure 14: Section of sub-main sewer line

These sewer in generally open in many areas but some of them are cover too with concrete slab. Different areas having different sizes of sewers according to the amount of sewage generated.

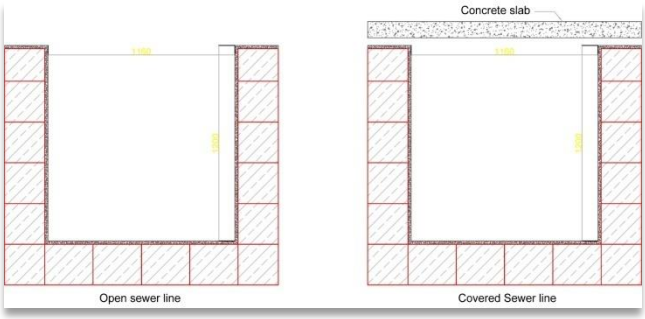

Figure 15: Section of main sewer line

Narrow sewer line is made in small streets, which receive waste water from household, which again drained to sub-main sewer line and further drained to main sewer line, which carry sewages to the STP or water bodies.

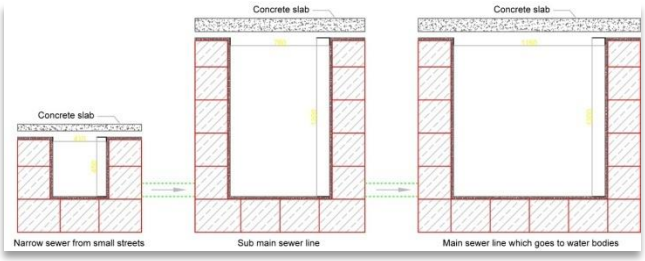

Figure 16: Flow direction of sewers

However, the number of individual onsite disposal units which are cleaned or maintained at intervals, is 75,360 (septic tanks or soak pits), covering 51 % of the total properties. There are 41 community toilets and 25 public urinals. The total sewage generated in city is 150 MLD approximately.In Ranchi Master Plan-2037, there is proposal of three STPs at three dams namely Dhurva Dam (56.83 MLD), Getalsut Dam (70.58 MLD), Kanke Dam (19.5 MLD).

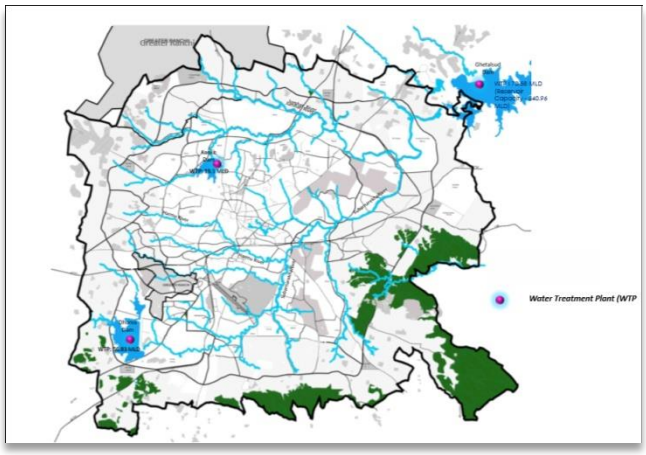

Figure 17: Location of existing STPs, Ranchi

PROBLEMS EMERGED DUE TO IMPROPER SEWERAGE SYSTEM

Sewerage system of Ranchi is constructed according to the old time capacity of sewage generated, but now as the population increased, the production of sewages also increased. So the capacity of sewers is not enough for current time, as its width and depth is low. So most area of Ranchi city suffers from waste water over flow mostly in rainy season and chock problems in summer season. Many small and large scale chemical industries are located in Ranchi and they drain industrial waste water into sewers, which get chock in summer season which further create problem of over flow as the sewers are choked.

Figure 18: Sewer over flow during rainy season

As industrial waste is directly drained into sewer which creates problems for sewage flow as well as they also pollute water bodies. As most sewer line is open, people throw solid waste into it which cause problems like sewer choking, waste water over flow. Which create unhealthy environment and spared disease sometimes like Malaria, Dengue etc.

One sewage treatment plant (STP) of 4MLD capacity has been installed at the downstream of the Kanke dam to prevent it from getting polluted. There are two major industrial areas in the city, which have separate sewerage systems. One 4MLD STP has been set up for the industrial and housing units of these areas, serving a population of 60,000. (This is only 0.5% of Ranchi's total population).

S. No	Indicator	Value
Sewerage and Sanitation		
1	Coverage of toilets *(0 toilets connected to sewerage network+0.84 lakhs toilets have onsite system+ community toilets/1.11 properties)*	77%
2	Coverage of waste water network services	0
3	Collection efficiency of waste water network	NA
4	Adequacy of waste water treatment capacity	NA
5	Quality of waste water treatment	NA
6	Extent of reuse and recycling of waste water	NA
7	Extent of cost recovery in waste water management	NA
8	Efficiency in redressal of customer complaints	NA

Figure 20: Data of service-level indicator (Sewerage), Ranchi

GOVERNMENT INITIATIONS FOR BETTERMENT OF SEWERAGE SYSTEM

The long-awaited sewerage and drainage system in the State capital cleared the first hurdle after lingering for

months since the first instalment was sanctioned for zone-1 of the project that is a part of Jawaharlal Nehru National Urban Renewal Mission (JnNURM).

RMC had prepared a city development plan in 2006-07 under JnNURM. As per the gaps mentioned in the CDP, the sewerage project was identified at the second stage, after the completion of the water supply project in the city and an external consultant was hired for the sewerage project. The detailed project report has been submitted to the commissioner for approval. The project is envisaged for year 2037 with a projected population of 30 lakhs. (Dailypioneer, 2014)

Table 1: Data for proposed sewerage system in Ranchi, Ranchi Master Plan-2037

FOR POPULATION OF	30 Lakhs
LENGTH OF SEWER NETWORK(KM)	783
NOS. OF PUMPING STATIONS	9
NOS. OF STPs.	3
TOTAT CAPACITY OF STPs	450 MLD
COST OF THE PROJECT	723.69 crores

Existing sewerage system is run and maintained by Ranchi Municipal Corporation. Sewers are cleaned twice in a week, and sewages are carried out by tractors or pull-cart.

Toilet Facility	Total HH covered	% covered
Own Septic Tank /Flush	5,448	21%
Own Dry Latrine	3,448	14%
Shared Septic Tank/Flush Latrine	443	1.8 %
Common Septic Tank/Flush Latrine	167	0.66
Community Dry Latrine	173	0.68
Open Defecation	15,578	61%
Total Households In Slum	**25,479**	

Figure 21: Data of services provided in slum by Government of Jharkhand

The total sewage generated in city is 150 MLD approximately in Ranchi Master Plan-2037, there is proposal of three STPs at three dams namely Dhurva Dam (56.83 MLD), Getalsut Dam (70.58 MLD), Kanke Dam (19.5 MLD).

SOLUTION TO IMPROVE SEWERAGE SYSTEM IN RANCHI

As we know Ranchi having plateau topology and annual rain of 1367 mm annually. Which don't require separate sewer line for storm water drainage. This city may adopt combined sewerage system over existing sewerage system.

REPLACEMENT OF EXISTING SEWERAGE SYSTEM BY COMBINED SEWERAGE SYSTEM

Ranchi having three types of sewer line according to its dimension and the main sewer line having 4 feet. Combined sewerage system is type of sewerage system in which there is a large networks of underground pipes that convey domestic sewage, industrial wastewater and storm water runoff in the same pipe to a centralised treatment facility.

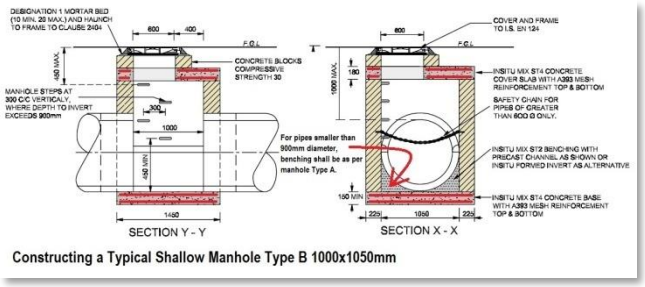

Figure 22: Section of typical shallow manhole type-B, Combined sewer

As Ranchi having plateau topology we can use its natural slope for installing sewer to provide gradient flow. Either sewer may installed on the trench of existing sewer line or trench may be constructed for sewer. If we use trench of existing sewer line to install combined sewer line, it will reduce its construction cost. RMC had prepared a city development plan in 2006-07 under JnNURM. As per the gaps mentioned in the CDP, the sewerage project was identified at the second stage, after the completion of the water supply project in the city and an external consultant was hired for the sewerage project. The project is envisaged for year 2037 with a projected population of 30 lakhs. (Dailypioneer, 2014)

Due to following factors combined sewerage system is better solution for Ranchi:

- Ranchi city receive 1367 mm rain annually, so no need of separate sewerage system.
- Combined sewer may be laid on existing sewer lines.
- Underground sewerage system would prevent this city from many drainage problems like overflow of waste water, diseases spread due to open sewer etc.
- It would provide healthy living and environment.
- Due to plateau region, combined sewer line get adequate gradient flow.
- Existing sewer is not capable for the sewages generated today, as it is of old time.

Because the wastewater is not treated before it is transported, the sewer must be designed to maintain self-cleansing velocity (i.e. a flow that will not allow particles to accumulate), generally obtained with a minimal flow of 0.6 to 0.75m/s. A constant downhill gradient must be guaranteed along the length of the sewer to maintain self-cleansing velocity. When the required slope cannot be maintained, a pumping station must be installed. Primary sewers are laid beneath roads, at minimal depths of 1.5 to 3 m to avoid damages caused by traffic loads. Access manholes are set at regular intervals along the sewer, at pipe intersections, at changes in pipeline direction and at drops.

Figure 23: Construction of combined sewer

CRITERIA	CHANDIGARH	MUMBAI	RANCHI	INFERENCES
GEOGRAPHY	• Lying in the northern plains. • Humid subtropical climate • average elevation is 321 m.	• Lying on mouth of Ulhas River on the western coast of India • Tropical wet and dry climate • average elevation is 14 m.	• Located in the southern part of the Chota Nagpur plateau • Moderate climate • average elevation is 651 m	• Network of sewerage system depends upon the geography of that area.
TYPE OF SEWERAGE SYSTEM	• Combined sewerage system (Underground)	• Combined sewerage system (Underground)	• Open sewerage system, some of them are covered with concrete slab.	• Combined sewerage system if more effective in Indian state.
CONSTRUCTION	• Made up of precast concrete • Circular in shape	• Made up of precast concrete • Circular in shape	• Stone Masonary • Rectangular in shape	• Sewers are either in circular or in rectangular in shape in India
NOS. OF STPs	• 3	• 64	• 1	• Sewerage Treatment Plant should be as per sewage generated.
CAPACITY OF STPs	• 35 MGD	• 1998 MLD	• 4 MLD	• The generated sewage is not treated completely in many municipal area in India
MAINTENANCE AUTHORITY	• Chandigarh Municipal Corporation	• Mumbai Municipal Corporation	• Ranchi Municipal Corporation	

COMPARATIVE ANALYSIS OF LITERATURE AND CASE STUDIES

Construction of Sewage Treatment Plant on Major Dams

One sewage treatment plant (STP) of 4MLD capacity has been installed at the downstream of the Kanke dam to prevent it from getting polluted. There are two major industrial areas in the city, which have separate sewerage systems. One 4MLD STP has been set up for the industrial and housing units of these areas, serving a population of 60,000. (This is only 0.5% of Ranchi's total population).

The total sewage generated in city is 150 MLD approximately. In Ranchi Master Plan-2037, there is proposal of three STPs at three dams namly Dhurva Dam (56.83 MLD), Getalsut Dam (70.58 MLD), Kanke Dam (19.5 MLD).

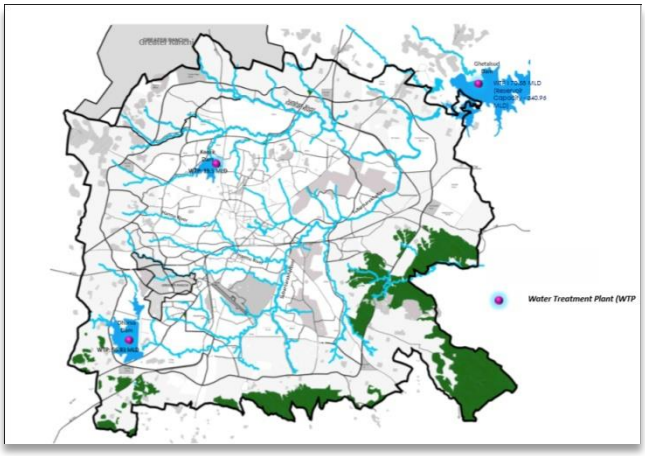

Figure 24: Location of three proposed STPs in Ranchi, Ranchi Master Plan-2037

CONCLUSION AND SUGGESTION

- From the study and analysis it is evident that sewerage system of Ranchi needs to be reconstructed to get rid of problems due to sewer failure. Because sewerage system of Ranchi is too powerless to take load of sewages generated today. There is proposals of well-planned sewerage system in Ranchi Master Plan-2037, which need to be completed till 2037. As this city having plateau topology and moderate annual rainfall, we can install combined sewerage system, as installed in other cities of India like Chandigarh, Mumbai etc.
- Many problems occur due to improper sewerage system of city like over flow of waste water, sewer chocked during summer season, spread disease in rainy season. No industries having own primary sewerage treatment plant in this city, which needed a primary Sewage Treatment Plant (mentioned in Ranchi Master Plan-2037). So that they can reduce some amount of toxic materials from industrial waste water before reaching to Sewage Treatment Plant (water bodies).
- The instalment of underground combined sewerage system would remove many problem and city would get a healthy living and environment. After the installation of underground sewer line, solid waste would not enter into sewers and prevent it from being overflowed or being choked.
- As the name of Ranchi city is mentioned in the list of upcoming Smart Cities of India. Hence sewerage system for a smart city is a major factor and it should be well planned for betterment of city and people as well. Because this city is growing in rapid scale as it is capital of Indian state of Jharkhand population is increasing rapidly day by day. And existing sewerage system is not able for today's sewage generation.
- So by this study and analysis I suggest that combined sewerage system is a better replacement of existing sewerage system for Ranchi in all aspects.

The total sewage generated in city is 150 MLD approximately in Ranchi Master Plan-2037, there is proposal of three STPs at three dams namely Dhurva Dam (56.83 MLD), Getalsut Dam (70.58 MLD), Kanke Dam (19.5 MLD). So that waste water generated from every sector like residential, commercial, industrial could be treated before discharging to water bodies.

At last I would say that government may take initiatives towards the installation of combined sewerage system in Ranchi with a proper treatment facility for a better future of city and people as well. And we can get a well-planned sewerage system and a healthy living, which is beneficial for the development of Ranchi for today and tomorrow.

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